Saskatchewan
Agriculture

Grasshopper Control

Grasshopper Control

Prepared by
J. L. Harris,
Pest Control Specialist,
Saskatchewan Agriculture,
Regina, Saskatchewan;

in co-operation with: J. A. Buchan, Saskatchewan Department of Agriculture; A. B. Ewen, Canada Department of Agriculture; J. A. Frowd, Saskatchewan Department of Agriculture; L. A. Minja, Saskatchewan Department of Agriculture; M. K. Mukerji, Canada Department of Agriculture; P. W. Riegert, University of Regina; and D. R. Weisbrot, Saskatchewan Department of Agriculture.

Artwork and manuscript design prepared by: D. Adams and A. Anderson

Photos supplied by Saskatchewan Department of Agriculture, Canada Department of Agriculture; R. Long, Waterhen Film Production, Balgonie, and W. N. Hurd, Outlook, Saskatchewan.

Revised 1985

Contents

Introduction 2
- Economic importance of grasshoppers 2
- Symptoms of infestations 2

Description of the insect 3
- The grasshoppers 3
- Important species 3
- Life cycle 5
- Annual cycle 5

Control of grasshoppers
- Weather's effects 6
- Natural enemies 7
- Cultural control 8
  - Early seeding 8
  - Crop rotation 8
  - Tillage 8
  - Trap strips 8
- Chemical control 10
  - Locating and estimating the seriousness of infestations 10
  - Timing of treatments 10
  - Choosing an insecticide 11
  - Spraying conditions 11
  - Assessing insecticide application 11
- Legal control 18
  - Your responsibilities 18
  - Municipal responsibilities 18
  - Provincial government responsibilities 18

Insecticide safety 12
- Mode of action 12
- Symptoms of insecticide poisoning 12
- First aid 12
- Steps to chemical safety 13
- Environmental hazard to non-target organisms 14
- Chemical registered for grasshopper control 15

The grasshopper forecast 16
- Forecasting methods 17

Summary
- A step by step guide to grasshopper control 18

Introduction

Grasshoppers are a major pest of cultivated crops and rangeland grasses of the world's semi-arid regions. Particularly susceptable are areas receiving less than 750 mm of precipitation in the form of rain or snow. Since much of Saskatchewan lies within this area, agricultural producers in this province are subject to a recurring threat of crop loss due to this insect.

- **Economic Importance of Grasshoppers**

Annual losses of cereal grains due to grasshoppers in Saskatchewan have been placed at approximately $5 million and on occasion have exceeded $40 million. Forage losses are seldom estimated but it has been shown in Alberta that even a moderate infestation of 10 grasshoppers/square metre can consume 16-60% of the available forage depending on the condition of the forage stand.

- **Symptoms of infestations**

The type and extent of crop damage will depend upon how well the crop is growing, the number of grasshoppers present, and whether or not adequate cultural and chemical controls are used.

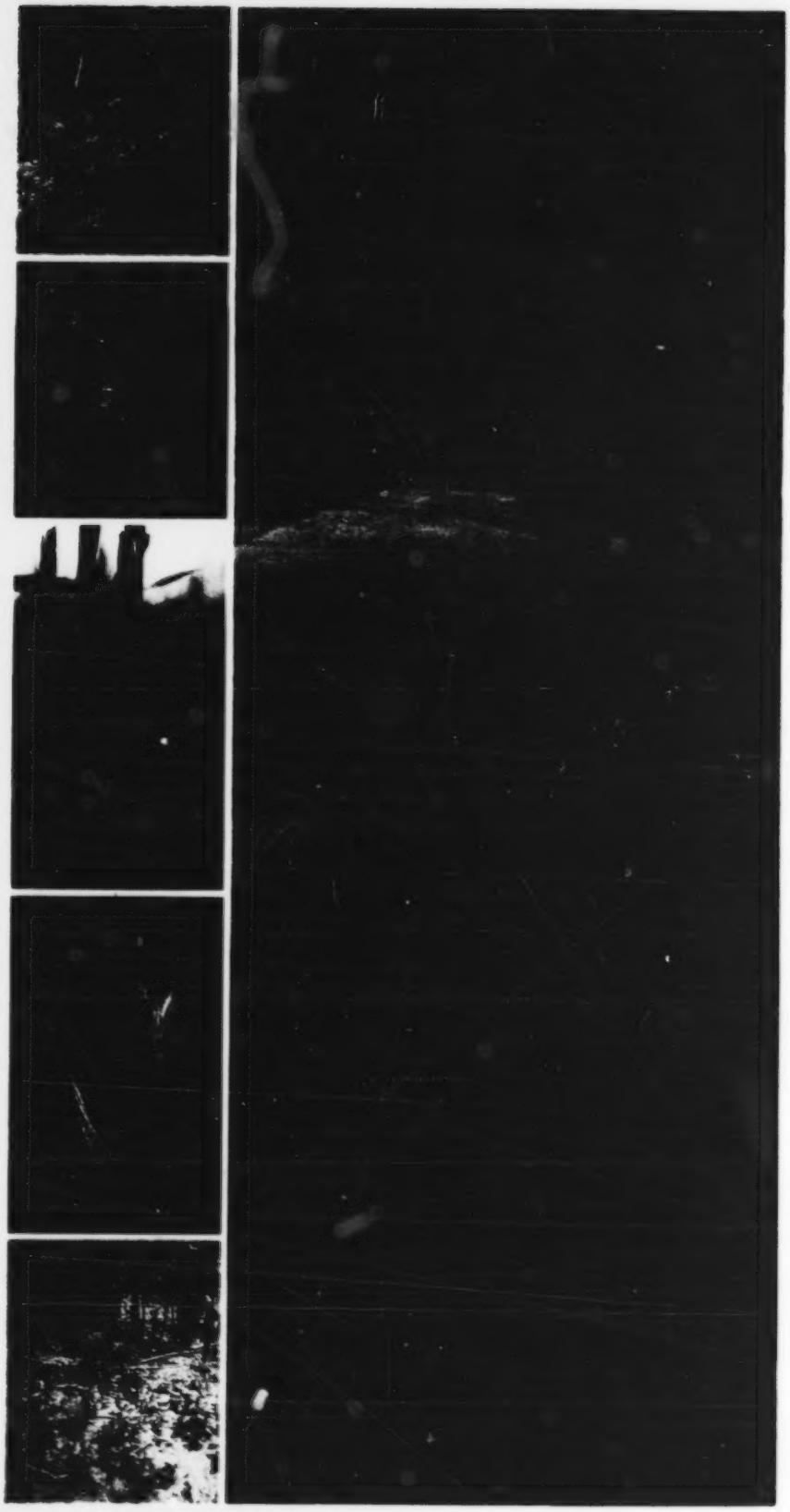


Figure 1 — Conditions are ideal for controlling these grasshoppers — there is a large 3rd instar grasshopper population and there is a minimal amount of crop damage.

Figure 2 — Crop is showing signs of emargination as the young grasshoppers gradually destroy the seedlings. Chemical control was delayed about 3-5 days too long.

Figure 3 — Gradual defoliation of older plants suggests that there was a moderate infestation which was not controlled early enough or that the crop was invaded by grasshoppers later in the season.

Figure 4 — Head clipping or feeding on ripening kernels of grain is occasionally seen during a moderate grasshopper infestation of a crop which has few leaves (i.e. flax). These symptoms may also be visible if the crop is ripening and there are few leaves that are acceptable as food.

Figure 5 — Crop damage resulting from inadequate control of a medium to large grasshopper population either in this field or in an adjacent field.

Figure 6 — Extensive crop damage despite chemical control due to grasshoppers moving into a crop from an adjacent shelter belt and/or summerfallow field.

Description of the Insect

The Grasshoppers

Grasshopper is the name given to a very large and diverse group of insects. All members of the group are characterized by chewing mouth parts, slender bodies, narrow hard forewings covering hindwings that fold lengthwise, large powerful hind legs for jumping and a gradual change in form and size as they develop. Grasshoppers are divided into two major subgroups, the short horned grasshoppers (Figure 7) and the long horned grasshoppers or katydids (Figure 8). The short horned grasshoppers are responsible for most of the reported crop losses and is the subgroup popularly referred to as "grasshoppers".

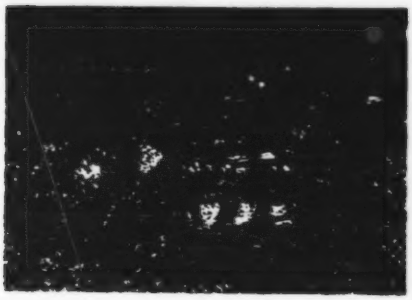


Figure 7 — General appearance of the short-horned grasshoppers

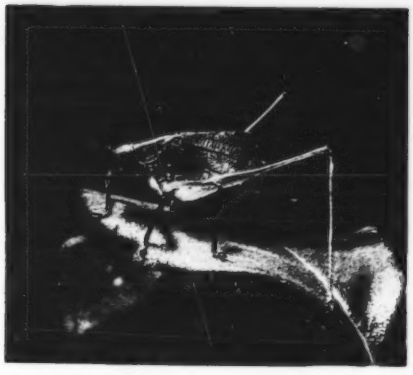


Figure 8 — General appearance of the long-horned grasshoppers

North America has more than 600 species of grasshoppers. In Saskatchewan there are more than 85 species. Fortunately, only a very few species are major pests here. The species that are considered pests are economically important because under ideal food and weather conditions they multiply quickly and when present in large numbers they feed extensively on crops.

Important Species

The short horned grasshoppers are divided into three types; (1) the spur-throated grasshoppers, (2) the band-winged grasshoppers, and (3) the slant-faced grasshoppers. Each type has distinguishing characteristics which make them relatively easy to identify. It is important that farmers recognize these characteristics if they are to control grasshoppers effectively.

(1) The Spur-throated Grasshoppers

These grasshoppers are identified by the presence of a tubercle or knob between their front legs (Figure 9). Most of the damage caused by grasshoppers is done by members of this group. The main species of this group are the Migratory or Stubble Grasshopper, Packard's Grasshopper, and the Two-Striped Grasshopper.

Figure 9 — General appearance of the spur-throated grasshoppers

- **The Migratory or Stubble Grasshopper**

Distinguishing characteristics — Adult grasshoppers are brownish to yellowish in colour and approximately 23-28 mm (0.9 to 1.1 inches) long. Their hind legs are marked with a series of black bands. The newly hatched grasshoppers have black bands on the top of their thorax. In the adult stage, these bands are on the sides of the thorax (Figure 10).

Figure 10 — The Migratory grasshopper, *Melanoplus sanquinipes*

Habitat — The Migratory Grasshopper lays its eggs mainly in stubble fields, but also in drift soil, weedy pastures, brome and alfalfa pastures, and roadside ditches. Summerfallow fields kept free of weeds are generally free of eggs even though they may have a substantial covering of trash.

Food supply — Because it is a mixed feeder, the Migratory Grasshopper thrives in weedy grain fields, cultivated pastures and hay fields. Large numbers of them may be found in crops adjacent to stubble fields especially if these fields are summerfallowed in late spring and trap strips have not been used. Those grasshoppers hatching amongst crops seeded on stubble fields feed on growing seedlings and damage may go unnoticed until extensive leaf chewing has taken place. Extensive head clipping may occur in late summer when much of the leafy vegetation has been eaten or has matured.

- **Packard's Grasshopper**

Distinguishing characteristics — These adult grasshoppers are grey to dark yellow in colour and approximately 27-32 mm (1.1 to 1.3 inches) long. The central area of the head and main part of the body are almost black. Two light coloured stripes extend from just behind the eyes to the posterior margin of the thorax. The forewings are uniformly grey and lack distinctive stripes. The last two segments of the hind legs are blue-green (Figure 11). When newly hatched these grasshoppers are green to brown in colour with numerous dark flecks on the thorax and abdomen.

Figure 11 — The Packard's grasshopper, *Melanoplus packardii*

Habitat and food supply — This grasshopper prefers light textured soils with a scanty grass cover and is similar in other respects to the migratory grasshopper.

- **Two-Striped Grasshopper**

Distinguishing characteristics — The adult grasshoppers are brownish or greenish in colour with black or brown markings. They are approximately 26-40 mm (1.0 to 1.6 inches) in length. They have two pale stripes extending back from the eyes to the tip of the forewings. A solid black stripe is evident on the hind legs (Figure 12). Immature grasshoppers are green to yellowish brown in colour.

Figure 12 — The Two-Striped grasshopper, *Melanoplus bivittatus*

Habitat — This species is very common in the heavier textured soil zones. It is found along roadsides, in dried out marshes and in fields with crops.

Food supply — It prefers lush foliage such as many of the weed species found associated with marshes and roadside ditches. It is often a pest of alfalfa and other crops. Occasionally, it may feed extensively on some of the trees commonly used as shelterbelts.

(2) **The Band-Winged Grasshoppers**

The main characteristic of band-winged grasshoppers is that the hind wings are usually brightly coloured.

While in flight they may produce a crackling sound with their wings. The Carolina grasshopper with its black wings fringed with a pale border is

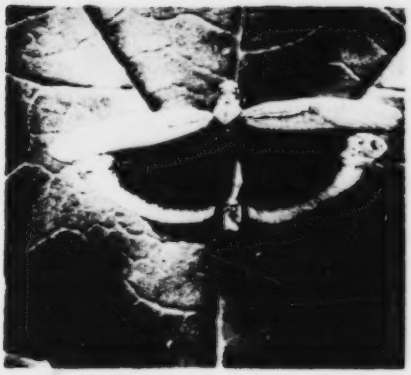


Figure 13 — The Carolina grasshopper. *Dissosteira carolina*

probably the most noticed member of the group (Figure 13). The most economically important species is the:

- **Clear-Winged or Roadside Grasshopper**

Distinguishing characteristics — The adults are yellowish to brownish in colour and approximately 21-32 mm (0.8 to 1.3 inches) in length. Their wings are clear but mottled with dark patches and they have two stripes beginning at the thorax and converging at the tip of the forewings (Figure 14). The newly hatched young are black in colour with a distinctive white band encircling the thorax.

Figure 14 — The Clear-winged grasshopper, *Camnula pellucida*

Habitat — The clear-winged grasshopper prefers to lay its eggs in sod on road allowances, overgrazed pastures and dried out marshy areas. Congregation of the adults during egg laying may result in as many as 10,000 or more eggs per square metre.

In the spring when young grasshoppers emerge they rapidly move from the egg bed sites into seedling crops. Where grasshoppers are numerous, scalloped field margins appear where the plants have been destroyed.

Food supply — The clear-winged grasshopper is primarily a grass feeder preferring cereal grains and some of the more succulent cultivated grasses. It seldom feeds on broadleaved plants. Large pastures of native grasses are usually only infested around their margins where cultivated fields are close by.

(3) **Slant-Faced Grasshoppers**

This group of grasshoppers are not as abundant as the other type of grasshoppers and often go unnoticed by the casual observer. The slant-faced grasshoppers are usually not abundant enough to warrant control.

The slant-faced grasshoppers are characterized by their elongate slender bodies, clear hind wings, conspicuously sword-shaped or occasionally club-like antennae, broadly rounded thorax, and a slanting to nearly horizontal face. An example of a typical member of this group is shown in Figure 15.

Figure 15 — General appearance of the slant-faced grasshoppers (e.g. *Amphitornus coloradus*)

Habitat — The slant-faced grasshoppers are usually found along the borders of marshes, in wet meadows. However some members of this group are also common in dry, grassy fields and pastures.

Food supply — The slant-faced grasshoppers feed primarily on rangeland grasses and sedges. They are seldom associated with cultivated crops.

The most abundant member of this group in Saskatchewan is the Club-horned grasshopper *(Aeropedellus clavatus)*. It is a relatively small grasshopper measuring 17-19 mm (.67 to .75 inches) in length. The males and females are usually greenish black. The females often have conspicuous cream, green and black markings on the head and thorax.

Life Cycle

The life cycle for all "economically important" grasshoppers in Saskatchewan is essentially the same. It begins and ends with the mating of sexually mature adults. During the two weeks following mating, the female grasshopper hunts for an appropriate site to deposit her eggs. Once she selects a site she bores a hole with her abdomen and deposits a cluster of cream to orange coloured, slightly bent, cylindrical eggs. She then deposits a foamy secretion over them. This secretion hardens to form an egg pod. The number of eggs per pod varies greatly, ranging from eight to one hundred and fifty. As a rule, grasshopper species which deposit few eggs per pod produce more pods than those which have many eggs per pod. Under favourable environmental conditions a single female grasshopper may produce an egg pod every two to four days. Consequently, an average female grasshopper can produce more than 250 eggs in her life time.

When the eggs are deposited the developing embryo within the egg is not visible. The egg appears to contain only a rather large bag of yolk (Figure 16a). The warm soil surrounding the eggs incubates them and the embryos become progressively more distinctive. The embryo development proceeds until winter sets in. By late fall the eggs of the clear winged grasshopper may be at one of the stages shown in Figure 16 b-d. In all these stages the embryo is small but generally distinct.

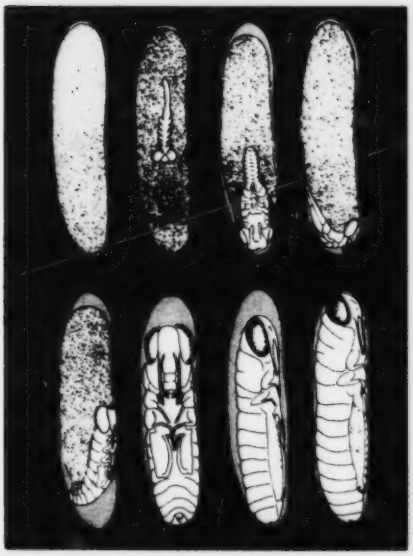


Figure 16 — Eight stages of development of an embryo within a grasshopper egg, from the time it is laid until it is ready to hatch.

Embryological development resumes in the spring as the soil becomes warmed by the sun. The embryo enlarges, hardens slightly and becomes more distinct. Figure 16-e shows the embryo revolving around one end of the egg and elongating. At this stage the grasshopper is still about three weeks from hatching if daytime temperatures reach 20° C.

As development continues, the yolk sac ceases to be distinctive from the insect but is enclosed within the developing body of the grasshopper. The reddish-brown pigmentation of the grasshopper becomes evident. At this stage, the grasshopper is seven to ten days from hatching at 20° C (Figure 16-f). Many eggs of the stubble grasshopper and the two striped grasshopper may have reached this stage before winter halts development.

When the embryo is within two to three days of hatching it resembles that shown by Figure 16-g. The pigmentation of the eyes and the legs are very distinct and the egg sac is no longer visible.

Figure 16-h illustrates the grasshopper when it is within one day of hatching. The grasshopper, then, fills the entire egg to bursting and shows distinctive black markings on the legs and other areas of the body.

Upon hatching the young grasshopper, enclosed in a transparent membrane emerges from the egg. This wormlike larva then penetrates the egg pod and wriggles its way to the soil surface, where it immediately sheds this membrane.

Newly-hatched grasshoppers, or nymphs, are approximately 5 mm (0.2 of an inch) in length. In appearance they resemble adult grasshoppers, except for their size and the absence of developed wings. After hatching, the young grasshopper begins feeding almost immediately on the surrounding plants. It prefers plants of small grains like wheat, barley, rye and oats.

Nymphal development consists of growth interrupted by periodic skin shedding (moults) (Figure 17). When food is abundant and the weather is warm but not too wet, it will take 35 to 50 days for the nymphs to go through the 5 (occasionally 6) nymphal stages before becoming a full-fledged adult. In all species the adult females are slightly larger than the males.

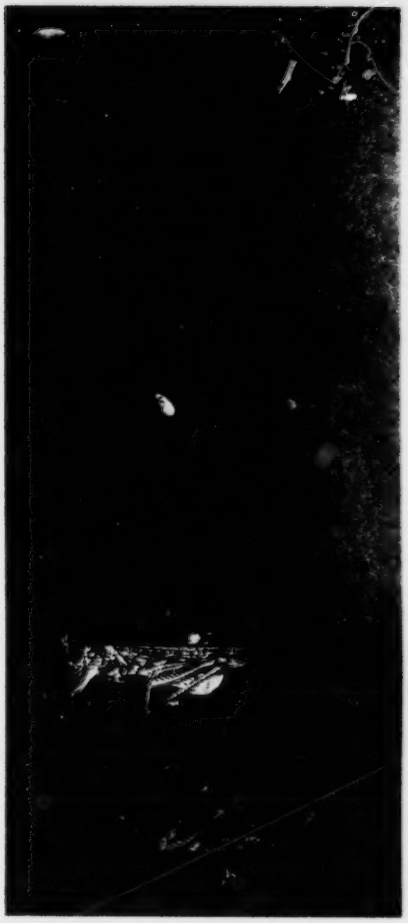


Figure 17 — Life cycle of the migratory grasshopper *Melanoplus sanquinipes* (actual size)

Annual Cycle

Although the life cycle of all grasshopper species is somewhat similar, the annual cycle may vary considerably. Variations between species depends on when the cycle begins and how long it lasts. For example, some grasshopper species overwinter as nymphs and a few overwinter as adults. These species are usually responsible for reports of grasshopper hatchings in early spring and late fall.

In Saskatchewan, no species has more than one generation per year. However, a few species would be capable of producing more generations if they were not limited by our long cold winters and short summers.

All of the economically important species in Saskatchewan begin their annual cycle in late summer or early fall of the preceding year, and overwinter as eggs.

Control of Grasshoppers

Weather's Effects

Temperature, rainfall and snowfall each play a major role in determining the severity of a grasshopper outbreak. They do so partly by regulating the size of the grasshopper population and partly by regulating the effect grasshoppers will have on developing plants.

Temperature is the most important factor determining the size of the spring grasshopper population — not the current year's spring temperatures but the preceding year's summer and fall temperatures. Those warm, summer days last year determine how fast the parents of this year's grasshoppers developed and began to lay eggs. Their speed of development in turn determined the maximum number of days available before October's and November's cool days stopped egg laying. Furthermore, the number of warm sunny days between mid-July and the end of September either encouraged or discouraged egg deposits. The more warm days there were during this period, the more eggs the female grasshoppers deposited. If conditions were ideal, the females may have been able to lay several hundred eggs.

To illustrate this point, in 1951 there was an initial hatch of grasshoppers, early in the spring. This was then followed by cool, rainy weather through much of June which delayed the rest of the hatch. As a result, many grasshoppers were still not adults in August so that few eggs were laid during the normal egg laying period. The autumn continued to be cool. By the end of the season very few eggs had been laid. As a result, there were very few grasshoppers in 1952 (Figure 18).

Therefore, if last year had numerous cool days between June and October, you can expect grasshopper numbers to decrease dramatically. The contrary is also true.

Winter temperatures can also have an effect on the current year's grasshopper population. Many grasshopper eggs will freeze if the snow cover is scanty and does not protect the eggs from the cold. For some grasshopper species, prolonged exposure to subzero temperatures can kill up to 90 per cent of the young inside the eggs. This may not be an important factor in most years as grasshoppers tend to lay their eggs in areas where snowfall usually accumulates.

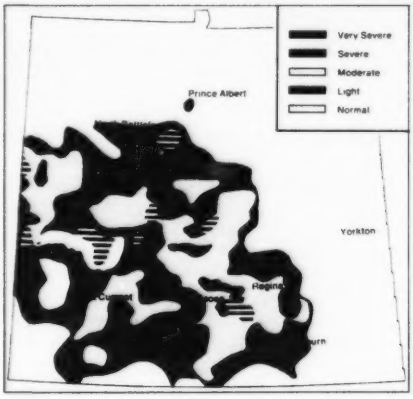
Spring temperatures will have only a minimal effect on the survival of the grasshoppers that hatch. Young grasshoppers are hardy enough to survive low spring temperatures, providing they do not persist for several days.

The most important aspect of spring temperatures is its affect on the grasshopper development and plant growth. If the spring is hot, grasshoppers will hatch early and develop quickly. A hot, dry spring also slows down crop growth.

The relationship between temperature and rainfall controls the amount of crop damaged by grasshoppers. Under dry, hot conditions a small grasshopper population may do as much damage as a large grasshopper population will under cool, wet conditions.

Weather plays a major role in determining the size of the grasshopper population and how extensive crop damage will be

1951 Grasshopper Forecast



1952 Grasshopper Forecast

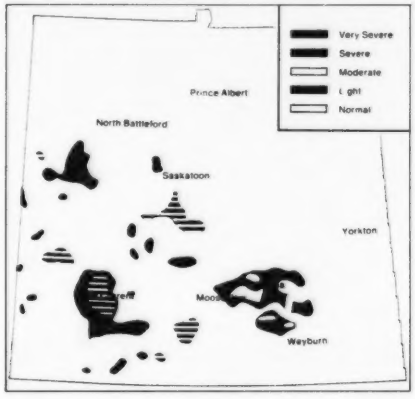


Figure 18 — A cool, wet spring and autumn in 1951 caused a dramatic reduction in grasshopper infestations between 1951 and 1952.

Moisture may also influence the size of the grasshopper population. During an extended drought, lack of water may stop the development of many eggs and destroy many others.

Rainfall may affect a localized grasshopper population to a lesser extent. Rainfall will only have an effect if a heavy downpour occurs immediately after an extensive hatch. A cool, wet June, however, will not seriously affect grasshopper populations.

The main effect of cool, wet, weather, is to reduce crop losses by hindering grasshopper development and promoting plant growth this year and possibly helping to reduce next year's grasshopper population.

Natural Enemies

Next to weather, the grasshopper's natural enemies are the most important factor controlling grasshopper populations. In some localized areas they may even be a more important factor than the weather.

Some of the grasshopper's enemies attack them when they are still in the soil awaiting the coming of spring. Others attack the nymphal and adult stages of the grasshopper.

• **Egg predators** — Among the most important of the egg predators are; bee flies, blister beetles, ground beetles, crickets and other insects. The adults of some of these insects, like the common field cricket feed directly on the eggs and may destroy up to 50% of the eggs in some areas. Others like the bee flies and blister beetles (Figure 19) deposit their eggs in the soil near grasshopper eggs.

Figure 19 — Adult (a) bee fly, and (b) blister beetle

When the larvae of egg predators hatch, they locate the egg pods, and feed directly upon the eggs. The larvae and pupae of a common blister beetle are shown in Figure 20. When bee flies and blister beetles are abundant they may destroy up to 80% of the eggs in a localized area.

Figure 20 — Larva and pupa of a common blister beetle

• **Egg parasites** — A few other insects, such as the wasp-like members of the genus *Scelio*, parasitize the eggs just after they have been laid. The young complete their development within the egg in time to parasitize the eggs of the next generation of grasshoppers. They may destroy from 5-40% of the eggs.

• **Nymphal and adult predators** — Spiders, some wasps and many birds may feed on grasshoppers and consume them in large numbers. However, their effect upon the total grasshopper population is not fully known.

• **Nymphal and adult parasites and diseases** — This group contains a large number of natural enemies including flesh flies, tachinid flies, muscid flies, tangled veined flies, thread worms, fungi, microsporidians and numerous others.

Most of the fly larvae either burrow into the grasshopper when they come into contact with it on the ground or they are deposited on or into the grasshopper's body. The fly maggot then feeds inside the grasshopper and eventually kills it as it leaves the body (Figure 21). This group of insects may have a cummulative parasitism of up to 60%.

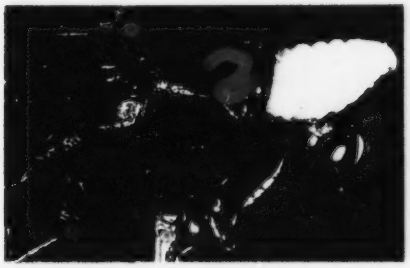


Figure 21 — Parasitic fly maggot as it leaves its host

"Threadworms" (Figure 22) are frequently found coiled inside grasshoppers. The "threadworms" overwinter in soil and lay their eggs on the soil or on vegetation. Threadworms attack grasshoppers if the young larvae encounter a grasshopper or if grasshoppers eat threadworm eggs.

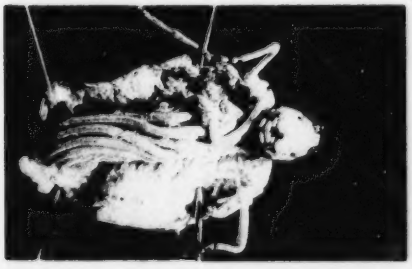


Figure 22 — A dissected grasshopper containing the threadworm, *Agamermis decaudata*

The fungus, *Entomophthora grylli* can be effective in controlling grasshoppers under warm, humid conditions. This fungus may occasionally reach epidemic proportions. The disease leaves the corpses of its victims clinging to the stems of plants (Figure 23).

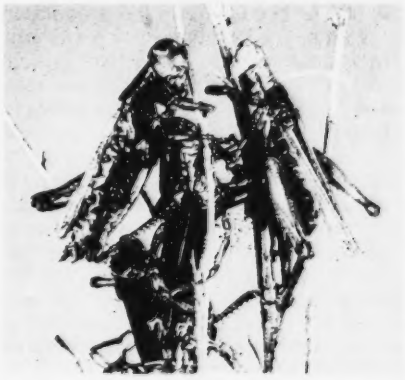


Figure 23 — Grasshoppers infected with the fungus, *Entomophthora grylli*

The microsporidian parasite, *Nosema locustae* has also been shown to be an effective enemy of grasshoppers (Figure 24). A grasshopper becomes infected if it ingests infected vegetation or an already diseased grasshopper. A grasshopper population infected with this organism may be reduced by as much as 60% in one year. It also appears that it affects grasshopper populations by reducing the number of eggs laid. This organism may offer some potential as a biological control agent.

Figure 24 — The infective stage of the microsporidian parasite *Nosema locustae* as magnified by an electron microscope

Since most of the natural enemies of grasshoppers are already widespread it is unlikely that they could be used to prevent grasshopper outbreaks over extensive areas. Nevertheless natural enemies do play an important role in controlling localized grasshopper infestations and are important in hastening the decline in grasshopper populations.

Cultural Control Methods

Of all the methods available for grasshopper control, cultural control methods are probably the least expensive. These methods do not require additional or special procedures. They merely involve variations in the time and manner of performing operations which are necessary in the production of a crop. By modifying the grasshopper's environment at certain critical periods of its life cycle, a farmer may eliminate them or reduce their ability to reproduce.

Despite the advantages cultural control methods offer, many farmers are reluctant to use them since it is difficult to assess their effectiveness. Nevertheless, they are effective, if they are implemented well in advance of any insect attack because they take time to work. **Cultural control is a preventive approach to insect control.**

The principal cultural methods used to control grasshoppers include early seeding of crops, crop rotation, tillage and trap strips.

• **Early seeding** — Crops should be seeded as early as possible. Older plants which are growing vigorously can withstand more grasshopper feeding than younger plants which are not well established.

Although early seeding may not totally prevent crop damage, it will reduce the amount of damage to crops and will allow more time for the farmer to obtain and apply insecticides.

Also, early-seeded crops mature early and migrating grasshoppers are not as likely to be attracted to them.

• **Crop rotation** — Whenever possible, avoid seeding cereals on stubble fields heavily infested with grasshoppers. Cereals should be seeded only on stubble fields where soil moisture is adequate and where one or more applications of an insecticide over the entire field is economical.

Seeding rape seed with an in-furrow application of terbufos (560 g ai/ha) or carbofuran (280 g ai/ha) may be a suitable alternative to seeding cereals where grasshopper infestations are not severe.

• **Tillage** — Cultivation of the soil is probably the most effective cultural practice available to farmers for the reduction or elimination of grasshopper populations. Tillage controls grasshoppers primarily by eliminating the green plants on which grasshoppers feed.

It is of little value to undertake tillage for the sole purpose of physically destroying grasshopper eggs or exposing them so that they dry out or are eaten by birds and other insects. Excessive tillage may even be harmful if it increases the risk of soil erosion.

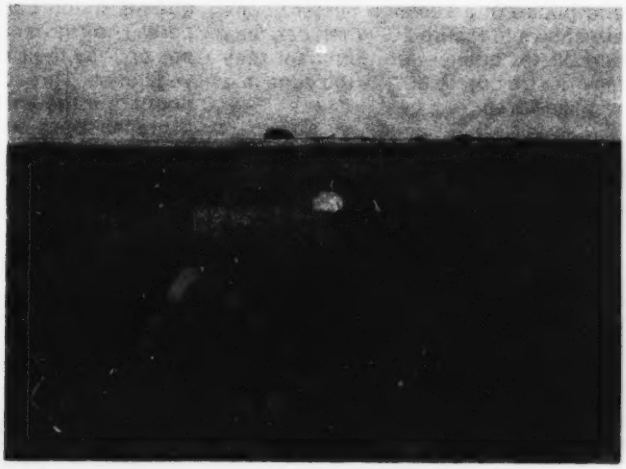
Fall tillage to rid weeds from summerfallow fields during late summer and early fall will discourage female grasshoppers from depositing their eggs in these fields. Grasshoppers seldom lay eggs in clean summerfallow even when it has a heavy covering of trash. Similarly, thorough cultivation of fields immediately after harvest will help discourage grasshoppers from laying all their eggs within the field.

It is advisable to complete early spring tillage to eliminate **all** green growth on stubble fields which are to be summerfallowed before the grasshoppers have hatched. If no food is available for them to eat when they hatch, the young grasshoppers will starve to death because they will be unable to move long distances to locate other food sources.

Early tillage will also give good weed control and conserve moisture at no extra cost. A tillage operation just to destroy grasshopper eggs is not recommended.

• **Trap strips** — If grasshoppers are present when tillage operations begin, it will probably be impossible to achieve adequate control by simply eliminating all green plant materials in a field. Once grasshoppers have fed and developed to the second stage of growth (2nd instar) in a field, they usually are mobile enough to move to adjacent crops when their food supply becomes exhausted. In these fields trap strips should be used to collect grasshoppers into a relatively small area. Then it will be possible to control them quickly and economically using a minimum amount of insecticide.

Weedy summerfallow provides an ideal environment with adequate food for developing grasshoppers during the summer.



Although weedy summerfallow is of little food value in the fall, it provides an ideal location for adult grasshoppers to deposit their eggs.

Figure 25 — An example of trap strips on stubble fields provided to concentrate grasshoppers after they have hatched

To make strips cultivate a black guard strip 10 m wide around the outside of a field. Leave an unworked green strip of at least 10 m before resuming cultivation (Figure 25). Repeat the process as often as necessary to produce additional trap strips.

All green vegetation must be eliminated between the trap strips if they are to be effective. The black guard strip in Figure 26 is adequate enough to ensure that grasshoppers will promptly move into the trap strips to feed. However this trap strip does not have enough vegetation to feed a large grasshopper population for more than one or perhaps two days.

The effectiveness of these trap strips can be improved considerably by seeding them to wheat, barley or oats several weeks before tillage begins. The trap strip in Figure 27 has adequate vegetation to feed even the largest of grasshopper populations for three to five days.

Migration of young grasshoppers from the cultivated guard strips to the trap strips may take several days. Once the migration is complete, the trap strips and a 10 m strip of any adjacent crop should be treated with an insecticide. The highest application rate recommended for the insecticide used should be applied to ensure adequate control is achieved.

Before cultivating the trap strips, allow three days to assess the effectiveness of the insecticide. If adequate control is not achieved after three days, it may be necessary to treat the trap strip again.

When grasshoppers have been eliminated from the trap strip, it should be possible to complete tillage without fear of displacing large numbers of grasshoppers into adjacent crops.

Summerfallow if it is not properly managed may be a major source of the grasshoppers which invade crops. Many of the reported cases of growers having to apply insecticides six or seven times to a field border are a direct consequence of improper grasshopper control on summerfallow fields.

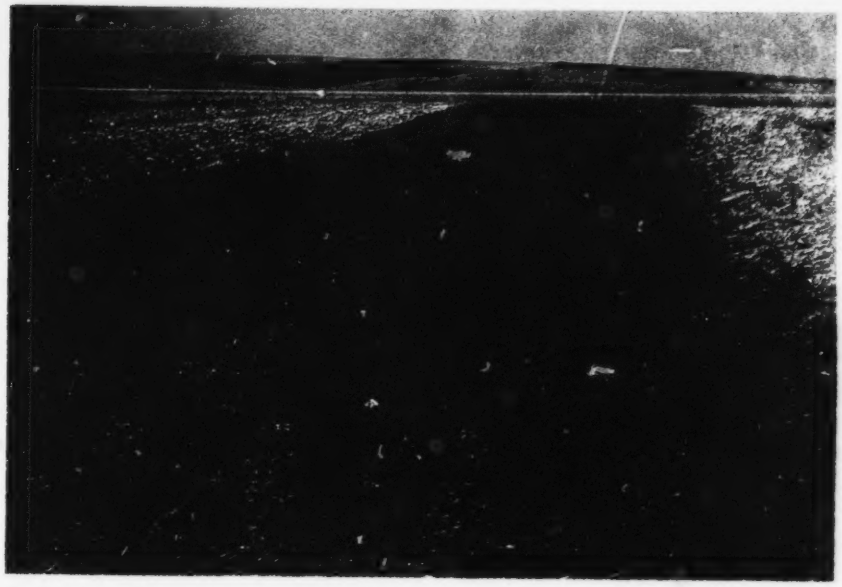


Figure 26 — Trap strip with adequate weed control on the guard strips but inadequate vegetation to feed a large grasshopper population for more than 1-2 days.

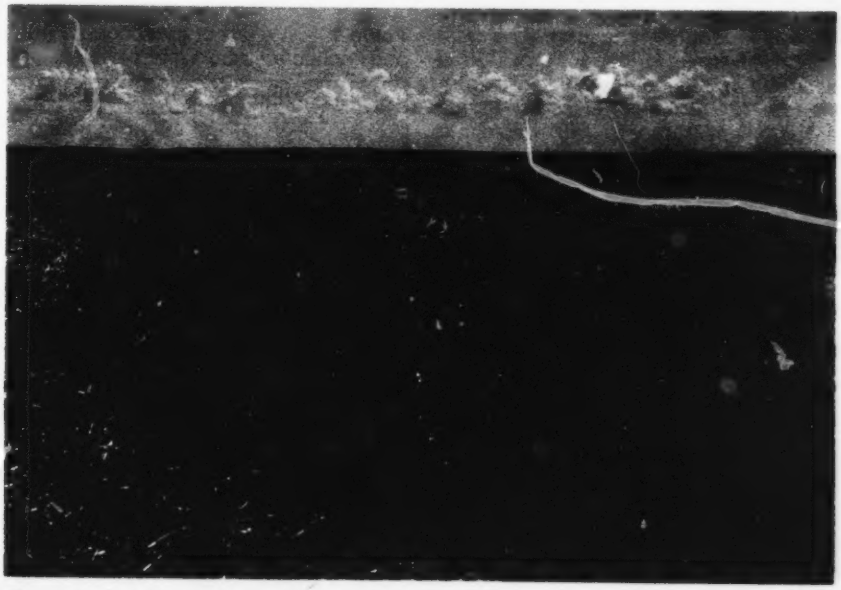


Figure 27 — Trap strip pre-seeded with barley will provide adequate vegetation to feed a large grasshopper population for several days but inadequate weed control on the guard strip will reduce the effectiveness of the trap strip.

Chemical Control Methods

Grasshoppers may not always be satisfactorily controlled by climate, biological or cultural control factors. Often insecticides must be used to reduce grasshopper populations to economically acceptable levels.

However, before a decision to apply an insecticide is made, several questions should be answered. These are: (1) How many grasshoppers are present in the crop or in the areas near the crop? (2) Are there enough grasshoppers to cause crop damage? (3) Will the cost of purchasing and applying an insecticide be more than the value of the crop that is to be saved? To answer these questions it will be necessary to first locate the grasshoppers, estimate how many there are, estimate the expected value of crops that could be destroyed and then calculate the costs of chemical treatments.

If the total cost of controlling grasshoppers is less than the value of the crop that they may damage, then an application of an insecticide is justified.

• **Locating and estimating the seriousness of infestations** — Several assessments of grasshopper populations should be made before applying any insecticide. The purpose of these inspections is to determine the site and size of potential infestation.

The first areas to be inspected should be those areas where grasshoppers were most abundant last fall. The most important areas to inspect are: (1) fall seeded crops (fall rye, and winter wheat), (2) stubble fields, (3) forage crops, (4) pastures, and (5) wasteland areas such as drift soil along headlands, field margins, sloughs, and fence lines.

Preliminary estimates of grasshopper infestations in these areas may be obtained as early as the first week of May by examining soil samples for grasshopper eggs. The easiest way to determine the number of eggs in an area is to take a soil sample of about one metre square (approx. one square yard), and about 50 mm (two inches) deep and pass it through a screen of 6 mesh hardware cloth (Figure 28). It will usually be necessary to take several samples from each location since the egg pods are usually not uniformly distributed throughout the soil. Table 1 can then be used as a guide to relate the number of egg pods found to an infestation level.

Figure 28 — Grasshopper egg pods collected by screening soil samples

These eggs can also be used to provide estimates of when the grasshoppers are likely to hatch. This is accomplished by:

(1) cleaning the eggs by removing the soil from the egg pods;

(2) placing the eggs in an alcohol solution to remove the wax coating from them;

(3) decolourizing the eggs by putting them in a mild solution of household bleach;

(4) examining the eggs under a magnifying glass; and

(5) comparing the development characteristics with the chart of known development times illustrated in Figure 16 on page 5.

Grasshopper eggs can hatch as early as the first week of May and as late as July. Hatching dates depend on the weather conditions of the spring and previous fall. As soil temperature increases, the rate of development within the egg increases. A warm spring and fall favours an early hatch. A cool spring and fall delays hatching. Generally, hatching takes place during a three week period beginning late May and continuing into June.

Once grasshoppers have begun to hatch it is essential that infested areas be inspected at least once a week. Three weeks after the hatch begins, these inspections should be made at least every other day. Inspections should be made during the warm part of the day when the grasshoppers are active. The more active the grasshoppers are, the easier they are to detect. Young grasshoppers are extremely small, (about the size of a kernel of rye) and are extremely difficult to detect, especially in dense plant growth. Inspections should be carried out on hands and knees so that the observer is close enough to see them. An insect net made of white cloth may be of assistance in detecting and catching small grasshoppers.

• **Timing Treatments** — Newly emerged grasshoppers do not necessarily need control, unless there are a great number of them. It is not advisable to control them unless they are

Table 1 — A chart of grasshopper infestation ratings as indicated by eggs or egg pods collected from 1 metre² soil samples from roadsides and fields.

Rating	Roadside	Field	
	# of egg pods	# of egg pods	# of eggs
Normal	0-1	0-.25	3-5
	2-6	.38-.5	6-10
Moderate	7-15	.75-1	11-20
	16-30	1.5-2	21-40
	>31	3-4	>41

Table 2 — A chart of grasshopper infestation ratings as indicated by nymph and adult populations and the appropriate action required.

Nymphs and Adults per m² (per metre step)			
Rating	**Field**	**Roadside**	**Control Measures**
Normal	0-3	0-6	not required
	4-6	7-12	usually not required
Moderate	7-12	13-24	may be required
	13-24	25-48	required
	over 25	over 49	required

about to cause significant amounts of crop damage in the near future.

Insecticide application should be timed to coincide with when nymphs are about 6-8 mm (0.3 of an inch) long. At this time most of the eggs should have hatched, but the nymphs will not have moved far from the place where they hatched. A quick screening of soil for eggs will confirm whether or not the hatch is complete. If the hatch is not complete, it may be necessary to make two applications of insecticide — one now and another two or three weeks later.

The earlier the grasshoppers are controlled on the egg bed areas in pastures, roadside ditches, sloughs and headlands, the better. A great deal of time and chemical can be saved by controlling grasshoppers while they are concentrated in rather small areas.

It is essential that stubble fields to be summerfallowed be weed free until after the grasshoppers have emerged or that trap strips are used to halt the migration of grasshoppers (see page 8).

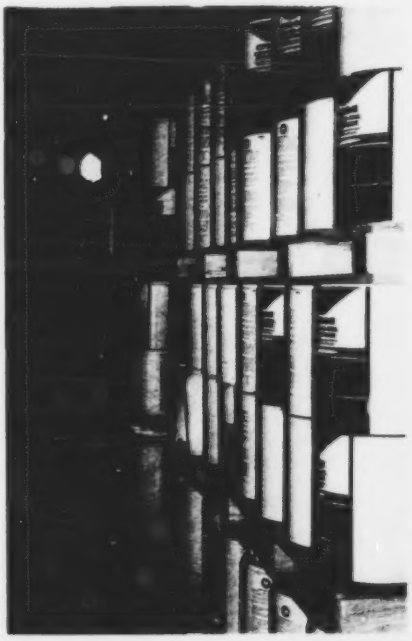
Cultivated pastures and hay fields should be treated with insecticides as soon as crop damage is noticed. If these areas are not treated with insecticide they may be a major source of grasshoppers infesting cultivated crops during late June and early July.

Crops grown on stubble fields as well as fall rye and winter wheat should be inspected frequently. Insecticides should be applied as soon as signs of crop damage are noticed.

Grasshoppers should be controlled when they are so numerous that the cost of controlling them is at least equal to the expected value of crop losses. The levels of adults and nymphs that require chemical control are shown in Table 2 (on page 10). These levels are only rough guidelines. **Chemical control may be required for smaller numbers of grasshoppers if the crop is stressed by drought or if it is an extremely valuable one.**

Grasshoppers should be controlled while they are still on the egg beds

- **Choosing an Insecticide**



Insecticides should be purchased as soon as it becomes evident that crop damage may occur to ensure that they are available when they are required.

Ideally the insecticide chosen should be environmentally safe, safe to apply, effective, persistent (for about 30 days) and inexpensive. Unfortunately, none of the insecticides registered in Canada for grasshopper control meet all of these conditions. Consequently, any insecticide selection will be a compromise based on; (1) the crops to be treated, (2) the availability of the insecticide, (3) the amount of time required between applying the insecticide and using the crop for grazing or harvesting, (4) how safe the insecticide is to the person applying it, (5) how long the insecticide stays on the crop or soil, (6) presence of other pests, and (7) the price of the insecticide per hectare.

Tables 4 and 5 (on page 15) provide a summary of information on the insecticides registered for controlling grasshoppers in Canada.

Regardless of the insecticide choosen, it will be most effective if it is applied to control immature grasshoppers rather than adult grasshoppers.

- **Spraying Conditions**

The best time to spray for grasshoppers is when they are small and actively feeding. There should be no wind or rain the day you are spraying, plant growth should be sparse, and your spraying equipment should be properly calibrated and operating well. If insecticides are used under these conditions, apply them at the lowest rate suggested on the label.

In most circumstances, the higher recommended rates will be necessary because one or more of the ideal conditions are not met. It is essential that the higher rate be used if the grasshoppers are concentrated in large numbers on trap strips or on egg beds, if there is extremely dense plant growth, or if you are spraying adult grasshoppers which are harder to kill.

Most insecticides work best at temperatures between 15° and 25° C. On extremely hot days air currents rising from the soil may reduce the amount of spray deposited, especially when it is applied by aircraft. Under these conditions, insecticides should be applied late evening or early morning. However, malathion should not be applied when temperatures are less than 20 degrees Celsius.

Insecticides containing carbaryl, cypermethrin or deltamethrin are most effective if applied at low temperatures. Nevertheless, do not try spraying when temperatures are abnormally cold or when the weather is wet or windy.

- **Assessing Insecticide Application**

The effectiveness of an insecticide should be assessed before new grasshoppers hatch or others move into the crop from adjacent, untreated areas. In most instances these assessments should be made about 24 hrs. after the insecticide was applied for those insecticides whose primary mode of action is by contact only. It may be necessary to delay assessments for 36 to 48 hrs. for insecticides which kill primarily by ingestion. In all cases, it may be necessary to make a second application of insecticide, where adequate control is not obtained after three days.

If grasshoppers are present only at the edges of fields, this will indicate that the field is being reinfested from adjacent areas.

Insecticide Safety

Insecticides are poisons developed to kill insects. However, their ability to interrupt the life processes is not limited just to insects. Many insecticides can have serious effects on humans and other animals. In extreme cases, undue exposure to insecticides may even be fatal.

Accidental poisoning can occur to humans or other animals through, (1) prolonged skin exposure, (2) inhaling insecticide vapours or (3) by swallowing an insecticide. This may occur as the result of a single exposure to the insecticide (acute toxicity) or from continued exposure to small quantities (chronic toxicity) which do not seem to be injurious at first but may have less obvious cumulative effects.

(1) **Dermal exposure** — The most common form of insecticide poisoning occurs when insecticides are absorbed through the skin. It is more common than it should be because people tend to think of the skin as an impermeable membrane or may not be aware that they have been in contact with the insecticide. Insecticides can pass through healthy undamaged skin as well as damaged skin.

The areas around the eyes, under the arms and around the genitals are particularily vulnerable to absorption of insecticides. Occasionally small amounts of insecticides find their way into the eyes when contaminated hands are used to rub the eye or remove something from it. Absorption through the eye will require immediate attention. To prevent dermal exposure from insecticides goggles and protective clothing should be worn and clothing should be washed immediately after use.

(2) **Inhalation** — The fastest way to become poisoned is to inhale the fumes, vapours or dusts from insecticides. The insecticides then pass quickly into the blood stream from the lungs. Always use a respirator if it is required.

(3) **Ingestion** — The least likely cause of accidental poisoning comes about by taking the insecticide into the body through the mouth. Such poisonings are usually a result of an accident or more frequently because of inexcusable carelessness. Persons using insecticides should never use their mouths to blow out spray nozzles, or smoke or eat while handling insecticides.

Mode of Action

The organophosphate and carbamate insecticides do not become stored in fat. Hence, mild infrequent exposures to them do not result in cumulative effects within the body. However there is a danger, if there are repeated small exposures over a relatively short period of time. Most problems, however, are the result of fairly large exposures resulting in acute toxic reactions.

These insecticides function by interfering with the normal movement of signals from the brain which initiate muscle movements. Typically, the signal passes from the brain down through a number of nerve junctions. At each nerve junction a chemical (acetycholine) is released at one end of the nerve fibre to stimulate the next nerve. The chemical is then quickly destroyed by an enzyme (acetyl cholinesterase) so that the signal does not persist. The insecticides interfere with the normal movement of messages down the nerves by inactivating the enzyme at the nerve junction.

Symptoms of Insecticide Poisoning

Unfortunately, all insecticide poisoning symptoms are not the same. However applicators should be aware of the general symptoms of insecticide poisoning.

Mild Poisoning or Early Symptoms of Acute Poisoning — headache, fatigue, weakness, dizziness, restlessness, nervousness, perspiration, nausea, diarrhea, loss of appetite, loss of weight, thirst, moodiness, soreness in joints, skin irritation, eye irritation, irritation of nose and throat.

Moderate Poisoning or Early Symptoms of Acute Poisoning — nausea, diarrhea, excessive saliva, stomach cramps, excessive perspiration, trembling, no muscle coordination, muscle twitches, extreme weakness, mental confusion, blurred vision, difficulty in breathing, cough, rapid pulse, flushed or yellow skin, weeping.

Severe or Acute Poisoning — fever, intense thirst, increased rate of breathing, vomiting, uncontrollable muscle twitches, pinpoint pupils, convulsions, inability to breathe, unconsciousness.

First Aid

First aid is just that. It is an initial effort to help a victim of an accident while medical help is on the way. If an accident occurs immediately move away from the insecticides and the contaminated area. The next action you take will depend on the particular circumstances.

(1) **Insecticides splashed into eyes** — Wash the eyes with large amounts of water immediately and continue for approximately 15 minutes. Chemicals should not be added to the wash water. Seek medical attention as soon as possible.

(2) **Insecticides on the skin** — Remove contaminated clothing and wash the skin with plenty of soap and water immediateiy and repeat as often as necessary. Clean under finger nails and toe nails. Wash contaminated skin with rubbing alcohol.

(3) **Insecticides swallowed** — Vomiting should be induced if dilute or concentrated forms of non-corrosive insecticides which **do not** contain petroleum distillates are swallowed. The pesticide label will give specific instructions. Never induce vomiting if victims are unconscious or lying on their backs.

Should respiration become weak — give artificial respiration.

Doctor _____

Hospital _____

Ambulance _____

Poison Control: Regina 359-4545
Saskatoon 966-1010

Steps to Chemical Safety

The first step to the safe use of insecticides comes with the realization that insecticides are hazardous materials and their improper use may have serious consequences. When using insecticides always:

(1) **Read the label** — Insecticides should not be used until the information on its label has been read and understood. If the label is missing or incomplete do not use the insecticide. Every direction on the label should be carefully followed.

The label contains the following information:

- the name and amount of the toxicant,
- procedures to be followed while handling,
- a warning symbol indicating the appropriate human toxicity,
- crops which can be treated,
- volume of water to be applied,
- preharvest intervals,
- directions for storage,
- directions for container disposal,
- and the antidote in case of poisoning.

The relative toxicity of insecticides is recorded in terms of an LD_{50} value. This value is a statistical estimate of the amount of chemical which would be required to kill 50% of the test animals it is administered to under certain conditions. Considerable care must be exercised in the interpretation of these values even though they are the accepted standard for denoting hazard.

The LD_{50} is expressed in terms of milligrams of dose per kilogram of body weight of the test animals. This means that a much larger dose of insecticide will be required to kill 50% of the test animals as their body weight increases. It has been shown that these values may also be affected by the age, sex and even the strain of the test animals.

Several different types of animals are usually tested including, birds, dogs, fish, rabbits and rats. As might be expected different animals may vary in their susceptability to various insecticides. Thus, the LD_{50} values for dogs and rats may have little bearing on the values for humans. Nevertheless these values are useful as a measure of toxicity of insecticides as long as it is realized that they are not absolutes. **Note**: The smaller the LD_{50} value the more toxic the insecticide is likely to be. The poison hazards associated with some of the insecticides used for controlling grasshoppers are shown in Table 3.

Table 3 — Poison hazard of the insecticides used to control grasshoppers

Insecticide		Poison Hazard†
Common Name	**Trade Name***	
azinphos-methyl	Guthion*	
carbaryl	Sevin*	
carbofuran	Furadan*	
chlorpyrifos	Lorsban*	
cypermethrin	Ripcord*	
deltamethrin	Decis*	
diazinon	Basudrin*	
dimethoate	Cygon*	
malathion	Cythion*	

*Insecticides may be sold under different trade names than those listed as examples

†Red symbol indicates a high poison hazard, orange, moderate, and yellow, low

(2) **Obtain and use proper protective clothing** — Insecticides should be handled with extreme caution. It is essential that the appropriate safety equipment be worn.

- Insecticides of low toxicity have a precautionary symbol on the label enclosing the poison symbol. When handling these materials it is essential that you wear at least a long-sleeved shirt, long-legged trousers, a coverall type of garment, a hat, rubber gloves, and rubber boots. The trouser cuffs should be worn over the boots and the rubber gloves should be turned back to prevent unnecessary exposure to the insecticide. A water proof apron or jacket may also be useful (see Figure 29c).
- Insecticides of moderate toxicity have a warning symbol on the label enclosing the poison symbol. When handling these materials, it is essential that splash proof goggles be worn in addition to the protective clothing required by materials of lower toxicity (Figure 29b).

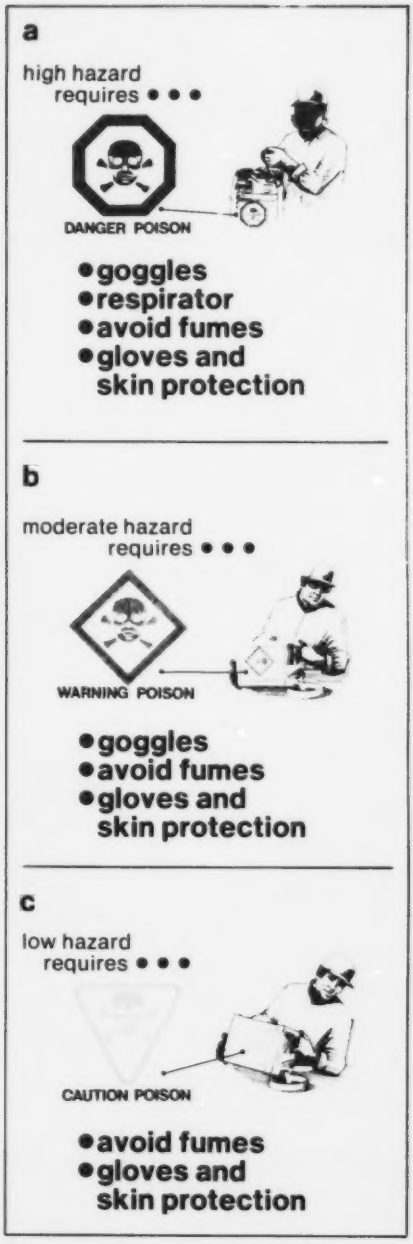


Figure 29 — Protective equipment required when handling insecticides of (a) high (b) moderate and (c) low toxicity

- Insecticides of high toxicity have a danger symbol on the label enclosing the poison symbol. When using these insecticides, it is essential to wear impermeable protective clothing and a respirator with proper cartridges (N.I.O.S.H TC-23C) for organic insecticide vapours in addition to the safety equipment required when handling moderately toxic insecticides (see Figure 29a).

Frequently, respirators are not properly used. Respirators will not be effective in protecting the applicator from toxic fumes unless they contain the appropriate cartridges and are used properly.

The cartridges supplied with the respirator should be those that are approved for use with organic vapours. Cartridges with a N.I.O.S.H. code **#TC-23C** should be the only cartridges used. Cartridges without this code # will not provide adequate protection.

The cartridges should be changed after about **8 hours** of use or sooner if pesticide odour is detected.

The filters over the cartridges protect the cartridge from direct contact with pesticides. They should be changed at least every 4 hours of use or more often if breathing becomes difficult.

The respirator must make a proper seal between the face and the respirator if it is to be effective. This means that the applicator must be clean shaven. Facial hair may allow the inhalation of pesticide vapours.

After use the respirator face piece should be washed in warm soapy water, rinsed thoroughly and dried with a clean cloth. Respirators should then be stored in a place where they will not be exposed to insecticide vapours.

(3) **Mix and handle insecticides carefully** — The greatest exposure to insecticides occurs during the mixing, loading and handling process. Before mixing insecticides always read the label instructions and wear appropriate protective clothing.

Insecticides should never be handled without protective clothing and equipment

- Insecticides should always be mixed outdoors in a place where there is adequate lighting, good ventilation and any possible spills can be cleaned up.
- When pouring insecticides stand up wind so as to avoid contaminating yourself.
- Insecticide cans should be held so the spout is at the top. This will help to avoid the splashing and spurting of insecticides while emptying the containers. If the container has an air vent, use it.
- If you feel ill while using insecticide, stop immediately and seek medical attention if necessary.
- Contaminated clothing should be changed immediately.
- Aerial applicators should never take part in mixing and loading operations and should stand well away from the area where they are taking place.
- Persons using insecticides should be prepared for an accident by making sure that soap, water and towels are available at the loading site.
- When containers of insecticide are empty, they should be rinsed at least three times and emptied into the sprayer tank.

(4) **Minimize insecticide drift** — Effective and safe application requires that the insecticide land on the insect. To ensure that results are not erratic, it is necessary that insecticides do not drift away from the target area. The factors that effect insecticide drift include, wind, droplet size, temperature and the distance between the nozzles and the target area. Insecticide drift can be reduced by:

- applying insecticides only when the wind speed is less than 11 km/h (7 mph).
- increase droplet size by altering nozzles or reduce spray pressure.
- apply insecticides during early morning or late evening to reduce possible evaporation of the spray and resulting vapour drift.
- place the spray nozzles at distances above the target that give adequate coverage.

(5) **Dispose of containers and clean up spills** — Information on chemical disposal and cleanup can be obtained from Saskatchewan Environment, 1855 Victoria Ave., Regina S4P 3V5, phone 565-6181. In the event of a spill the Spill Report Centre should be called 24 hr. toll free: 1 or 112-800-667-3503.

(6) **Decontamination of equipment** — Spray equipment and personal equipment should be decontaminated immediately after use.

- The sprayer tank should be rinsed with adequate water volumes and the tank contents sprayed on the field or emptied carefully watching where the wash water drains.
- Rubber gloves should be rinsed in water before proceeding with the removal of other safety equipment.

(7) **Decontaminate yourself** — The last step in a spray operation is to shower with adequate amounts of soap and water and put on clean clothing.

Environmental Hazards to Non Target Organisms

Wildlife — The recommended grasshopper insecticides do not endanger wildlife, including fish and birds, when applied at recommended rates and according to the precautions and limitations on the label.

Bees — All currently registered grasshopper insecticides are hazardous to honey bees and leafcutter bees. The following precautions should be taken when applying any grasshopper insecticide.

- Never apply insecticides to insect-pollinated crops during the flowering stage.
- Never apply insecticides to bee yards.
- Always give beekeepers a warning before spraying in the vicinity of beeyards or bee pastures.
- Always spray in the evening or early morning when bees are not in flight.

Poultry — There appear to be no harmful effects on poultry from consuming grasshoppers that have been sprayed with grasshopper insecticides, however, it is suggested that they be kept away from treated areas for at least two days.

Table 4 — Chemicals Registered for Grasshopper Control in 1985

Common name (trade name)	g ai/L	Container size	Days between application and harvesting or grazing: Barley	Oats	Rye	Wheat	Oilseeds: Rape	Flax	Mustard	Sun-flower	Non-cropland	Product/ hectare	product/ acre	acre/ container	Air L/ha	Air L/ac	$ † approximate cost/acre
→ Malathion (Malathion 500EC)	500	20L	7	7	7	7	7	7	7		7	1.70L	0.69L	29.0	20	8	4.31
→ *Methamidophos (Monitor 480L)	480	10L	10	10	10	10	10					1.15L	0.46L	43.1	10	4	4.71

† Approximate cost as of December 1984. Costs will vary depending on rates of application and source of supply.

* **Warning:** "Safety data and registration of this product under review. Directions for use and cautionary statements should be carefully followed. Read the label before using".

Insecticides recommended by the Western Committee on Crop Protection for grasshopper control.

● The inclusion or exclusion of specific insecticides by trade name in Table 4 does not imply nor does it constitute an endorsement of specific brands of insecticides by the Saskatchewan Department of Agriculture, but serve as examples of the materials readily available in Saskatchewan. Upon request additional examples may be included where space permits such additions.

Table 5 — Additional Information on Specific Insecticides

Restrictions and precautions

- Avoid spraying insecticides on flowering crops. If it can not be avoided, apply the insecticide late evening and notify surrounding beekeepers at least 3 days before making such applications.
- Decis® and Ripcord® are not registered for application by air.
- Furadan® should not be applied more than twice per season on cereals or forages and only once per season on oil seeds.
- Malathion should only be applied when temperatures are above 20°C.
- Residues — No harmful residues will remain in the soil, on crop plants, or in meat or dairy products when registered grasshopper insecticides are used in accordance with the label and when allowing the necessary waiting periods before harvesting or grazing crops or pastures.

Special Situations

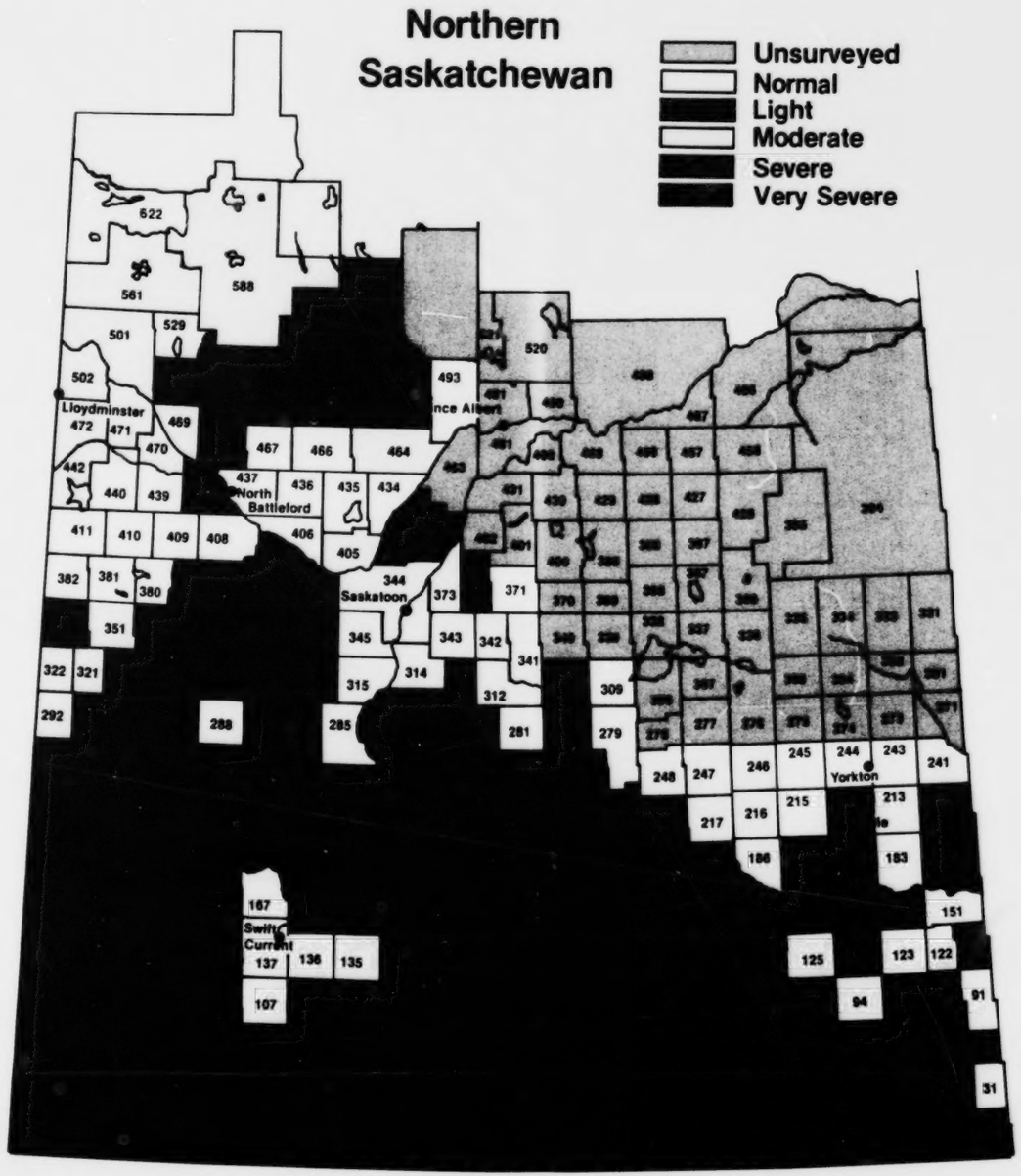
- Furadan® is the only insecticide that has a registered tank-mix. Furadan® may be mixed with 2,4-D or MCPA.
- Grasshoppers and cutworms in the same field
  - Lorsban® and Decis® are the only insecticides in the above list that have a registration to control both insects.

← This page is perforated and may be removed for quick reference in the field. Obtain a revised copy of this page each year.

Figure 30 — The Grasshopper Forecast in Saskatchewan—1985 *

Insecticide Spray Record 1985	

Expected Problem Area 1986	



* The Saskatchewan Grasshopper Forecast is produced annually as an update to the publication *Grasshopper Control*. Additional copies of this forecast can be obtained from district agricultural offices throughout the province or by writing to: Communications Unit, Regional Extention, B-33, 3085 Albert Street, Regina, S4S 0B1.

Forecasting Methods

The grasshopper forecast is produced annually and is presented in the form of a map (Figure 30). Its main purpose is to provide farmers, governments and industry with advance warnings of the serious grasshopper infestations in the following year.

A glance at the map enables farmers to see which areas of the province are likely to have enough grasshoppers to warrant control and which areas are likely to have too few grasshoppers to cause concern.

The forecast, however, is not specific enough to predict infestation levels for individual farms. Instead, it gives a general overview of infestations that may occur within municipalities.

The data on which this forecast is based is obtained in August of the previous year, when a number of survey technicians travel throughout the province stopping at locations near the centre of each township within the outbreak area. At each location the technician estimates the average number of grasshoppers encountered while walking 100 metres through the field and 100 metres along the roadside (Figure 31). Additional estimates are only made if the surveyor suspects that the initial samples are not representative of grasshopper abundance within a township.

Infestation ratings are produced from a combined rating chart using field and roadside counts (Table 6). The ratings are then plotted in corresponding colours on a map of the province and an overall picture of grasshopper distribution during the fall is obtained.

The forecast is therefore based on a very limited number of samples. However, in past years, these predictions have been shown to be reliable indicators of where grasshopper problems are likely to occur in the following spring.

Usually the areas with high infestation levels can expect larger areas of infestation and more crop damage than areas with lower ratings. However, crop losses from grasshoppers are possible throughout the province, regardless of the rating a particular area is assigned. It is important that all farmers inspect their crops regularly if they are to ensure that their crops are not those damaged by grasshoppers.

Table 6 — Combined ratings table used to predict the severity of grasshopper infestations from estimates of grasshopper abundance.

Grasshopper/m² on the roadside	Grasshoppers/m² in the field								
	0-1	1.5	2	3	4	5-6	7-8	9-12	>13
1-4	normal								
5-6									
7-8									
9-12			moderate						
13-16									
17-24									
25-32									
33-48									
>49									

Individual farmers can participate in the survey by obtaining data cards from their local agricultural representative. These cards should be filled out and returned during the second week of August.

Figure 31 — Estimates of grasshopper abundance are recorded as the average number of grasshoppers observed (1) along an arc of 100 metre strips in the field and (2) 100 metre strips along a roadside.

Legal Control

Grasshoppers can be extremely difficult insects to control. If one person neglects to control them on his property, the infestation may spread to adjacent crops. For this reason, the grasshopper was declared a pest under Saskatchewan's Pest Control Act on the 17th day of June 1957.

• **Your responsibilities** — It is the duty of every person who is in control of land to take measures to destroy, control and prevent the spread of grasshoppers on that land. If for some reason adequate control measures are not taken, an officer appointed by a municipality may require that such measures be carried out.

Where an officer is unable to reach an agreement with the owner or operator of the infested land for the control of grasshoppers an order may be issued requiring that such measures be taken. If the grasshoppers are still not controlled, the officer may take measures to control the grasshoppers and have the clerk or secretary treasurer send the property owner a notice setting forth the expenses incurred to control the grasshoppers. If these expenses are not paid by the thirty-first day of December in the year the expenses are incurred, they can be added to and form part of the taxes upon the parcel of land where the grasshoppers were controlled.

• **Municipal government responsibilities** — Local municipal councils are responsible for the appointment of officers to enforce pest controls. However, where an appointment has not been made, council must make such an appointment upon the receipt of a petition signed by twenty-five rate payers of a rural municipality. Municipalities are responsible for grasshopper control on municipal road allowances unless they have passed a bylaw transferring this responsibility to the person owning the adjacent property. Many municipalities have such a bylaw in place. Some of these bylaws also specify the means of controlling or destroying the pest.

A municipal council may also pass a bylaw providing for the purchase of materials required to control grasshoppers and distribute such materials on such terms as the council deems advisable. The costs of such material may be raised as a general tax on all lands in the municipality.

• **Provincial government responsibilities** — The Province of Saskatchewan provides information and technical assistance for the control of grasshoppers. In addition it works closely with industry and research institutes to ensure that Saskatchewan farmers have the most effective and safe means of grasshopper control made available to them. The Government of Saskatchewan is responsible for grasshopper control on provincial highway road allowances, provincially operated community pastures and provincial parks and wildlife reserves.

The Federal government is similarly responsible for grasshopper control on all lands over which it has control.

Summary

A Step by Step guide to grasshopper control

1. Know the egg bed areas
   a) Check egg laying sites where grasshoppers congregated last fall.
   b) Check ditch banks, slough margins, overgrazed pasture areas, drift soil, and stubble fields for eggs.
2. Check frequently for hatching (on hands and knees) starting in early May. Sandy soils and south facing slopes will show the first signs of hatching grasshoppers.
3. Do not seed stubble fields in moderate, severe, or very severe areas unless moisture reserves are excellent, and expected yields warrant extra cost of grasshopper control.
4. Begin summerfallowing before hatching occurs to starve newly-hatched grasshoppers.
5. If grasshoppers are hatching or have hatched when tillage begins, cultivate a guard strip around the outside of the field and leave green trap strips to attract the hoppers. Spray the strips when grasshoppers have congregated and complete tillage three to four days later.
6. **Before applying insecticides, study the label and follow directions carefully. Use recommended safety equipment.**
7. Spray as early as possible. Young hoppers are easier to kill, less mobile and often concentrated on small areas outside field crops.
8. Assess the area a day after treatment to determine the effectiveness of the spraying operation and to detect grasshoppers migrating from outside areas. Recheck every few days thereafter and respray, if necessary.
9. Remember, grasshoppers are a community problem. Control your own grasshoppers coinciding with your neighbour's program.
10. Keep in touch with the progress of the grasshopper campaign, through your campaign supervisor, agricultural fieldman, agricultural representative and the news media.

Remember insecticides should never be handled without protective clothing and equipment